Formation of β-Lactams from Tricarbonyliron Lactone Complexes

By GARY D. ANNIS, ELIZABETH M. HEBBLETHWAITE, and STEVEN V. LEY*
(*Department of Chemistry, Imperial College, London* SW7 2AY)

Summary A number of tricarbonyliron lactam complexes were prepared from the corresponding lactone complexes by reaction with amines in the presence of $ZnCl_2$ and on subsequent oxidation with Ce^{IV} gave β-lactams in excellent yield.

WE have recently shown that dienes can be converted into lactones *via* intermediate tricarbonyliron complexes[1,2] and now show that these complexes can also be used as suitable precursors for β-lactams.

TABLE 1. Formation of tricarbonyliron lactam complex from lactone complexes with $PhCH_2NH_2$–$ZnCl_2$

Lactone complex[a]	Lactam complex	M.p. °C	Reaction time/h	Yield/%
(1)	(8)	76—68	0·5	81
(2)	(9)	98—100	1·5[b]	75
(3)	(10)	80—86	3[b]	82
(4)	(7)	95—98	24[c]	46
(6)	(5)	98—100	3[b]	48

[a] Prepared from vinyloxiran and $Fe(CO)_5$.[1] [b] In Et_2O at room temp. [c] In tetrahydrofuran–Et_2O at room temp.

A number of tricarbonyliron lactam complexes were prepared in moderate to high yield by treatment of the lactone complexes with benzylamine in the presence of $ZnCl_2$ (Table 1). The lactam complexes were fully characterised by spectral and microanalytical methods. For example, the i.r. spectra show the carbonyl group at, typically, 1580—1595 cm^{-1}. The reversal of the initial substitution pattern of the tricarbonyliron lactones on formation of the lactam complexes by an S_N2'-like mechanism has been shown previously.[3]

The lactam complexes, on oxidation with ceric ammonium nitrate, gave β-lactams in excellent yield (Table 2) which showed carbonyl absorption bands at *ca.* 1750 cm^{-1}. This

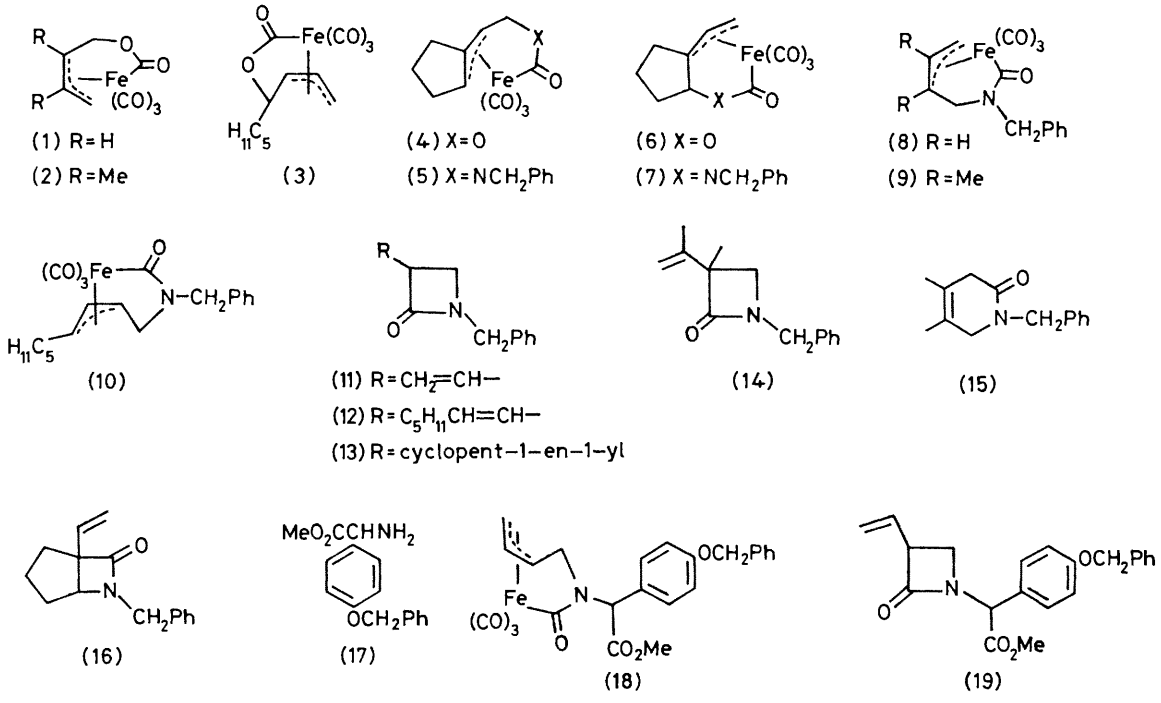
TABLE 2. Oxidation of tricarbonyliron lactams using ceric ammonium nitrate

Lactam complex	Product(s)	Reaction conditions[a]	Yield/%
(8)	(11)	−30 °C → room temp.	72
(9)	(14)	0 °C → room temp.	34
	(15)		56
(10)	(12)	−5 °C	64[b]
(7)	(16)	−30 °C → room temp.	75
(5)	(13)	room temp.	88

[a] 1 h in ethanol. [b] As a 50:50 mixture of *cis/trans* isomers.

value is consistent with many other examples in the literature.[4] Only in one example, (2), did oxidation lead to a significant amount of a δ-lactam (15).

Finally, in an effort to produce β-lactams of potential biological interest, we allowed (1) to react with the protected amino acid (17), again in the presence of $ZnCl_2$. The tricarbonyliron lactam (18) (ν_{max} 1590 cm^{-1}) was produced in 81% yield after 2 h at room temperature. On oxidation, the β-lactam (19) was produced in 80% yield. This β-lactam is clearly related to the nocardicins,[5] a novel class of β-lactam antibiotics.



We thank the S.R.C. and Beecham Pharmaceuticals, Ltd, Brockham Park, for research Studentships (G. D. A. and E. M. H., C.A.S.E. Award) and the London University Central Research Fund for an equipment grant.

(*Received, 17th January* 1980; *Com.* 058.)

[1] G. D. Annis and S. V. Ley, *J. Chem. Soc., Chem. Commun.*, 1977, 581.
[2] G. D. Annis, S. V. Ley, and R. Sivaramakrishnan, *J. Organomet. Chem.*, 1979, **182**, C 11.
[3] Y. Becker, A. Eisenstadt, and Y. Shvo, *Tetrahedron*, 1976, **32**, 2123.
[4] *E.g.* E. T. Gunda and J. Cs. Jászberényi, *Prog. Med. Chem.*, 1977, **14**, 203.
[5] 'Recent Advances in β-Lactam Antibiotics,' ed. J. Elks, Special Publication No. 28, The Chemical Society, London.